dHealth 2024
D. Hayn et al. (Eds.)

doi:10.3233/SHTI240005

Acceptance of Telepresence Robotics, Telecare and Teletherapy Among Stroke Patients, Relatives and Therapy Staff

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Abstract. Background: Stroke as a cause of disability in adulthood causes an increasing demand for therapy and care services, including telecare and teletherapy. Objectives: Aim of the study is to analyse the acceptance of telepresence robotics and digital therapy applications. Methods: Longitudinal study with a before and after survey of patients, relatives and care and therapy staff. Results: Acceptance of the technology analysed is high in all three groups. Although acceptance among patients declined in parts of the cases in the second survey after having used telerobotics, all in all approval ratings remained high. With regard to patients no significant correlation was found between the general technology acceptance and the acceptance of use of telerobotics. Conclusion: Accepted new telecare and teletherapies can be offered with the help of telepresence robotics. This requires knowledge of and experience with the technology.

Keywords. Telehealth, stroke, acceptability of healthcare, telecare, evaluation study

1. Introduction

Stroke is one of the most common causes of death worldwide and is the third most common cause of permanent disability [1]. The risk of stroke increases with age, meaning that older people are more often affected. In Germany, in the year 2015 stroke was still the third most common cause of death [2]. In recent years, advances in acute treatment and therapy options as well as improved care structures, for example by increased numbers of stroke units [3, 4], have reduced the mortality rate of stroke patients [5]. The falling incidence rate, which is determined for Germany based on two population-based stroke registers [5], is in turn due to improved prevention measures [6]. Further advances in treatment and therapy options will presumably and hopefully further improve the survival rate. However, demographic change with the increasing ageing of Western European societies means that an increase in the number of new cases (incidence) and the number of people affected (prevalence) can be expected in the coming decades [7].

In the coming decades stroke as a cause of disability in adulthood will result in increased pressure on rehabilitation services and a significantly growing need for care and therapy for those who benefit from the described progress. This demand will come

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up against the ever-increasing challenges in the care and therapy sector because of the growing lack of skilled labour [8]. Particularly in rural regions patients find it difficult to receive adequate follow-up care for their rehabilitation. In this context, hopes are pinned on new digital applications, although these are not yet widespread. Consequently, a comparative study on digitalisation in the healthcare sector found that Germany ranked 16th out of 17 countries [9].

For these patients, telepresence robotics can offer an opportunity to supplement existing outpatient services with digital offerings. Our interdisciplinary field study on the use of telepresence robotics by stroke patients was based on this objective [10]. The research project has been issued a positive vote by the Joint Ethics Commission of the Bavarian Universities of Applied Sciences (GEHBa-202007-V-004-R). The additional provision of care and therapy via telepresence was intended to enable the study participants to remain in their own home environment enabling them to lead a self-determined life while at the same time participating in society. The accompanying social science study presented here analysed the acceptance and willingness of the participants to use the system as well as the ethical, legal, and social aspects of its use.

2. Methods

2.1. Telepresence robotics in the research project

Telepresence robots (TPR) are initially defined as relatively simple devices that enable communication over distance. They can be controlled via the Internet and can move autonomously within a fixed environment [11]. In the field study of our research project, two variants of TPR were used in the home environment of stroke patients. Study participants were assigned one of two telepresence robot systems in an alternating procedure for a test period of 24 weeks after enrolment in the study.

The TPRs were equipped with applications for independent training aimed at speech therapy and physiotherapy (of the upper extremities) as well as (psychosocial) care after a stroke. Both had a screen with a touchpad. While the autonomous mobile version included a navigation system with voice control, the second, so-called "DIY version" (Do-It-Yourself) had a larger screen. It was designed specifically for the project. The DIY was able to fill the gap in the market created by the lack of data protection compliance of other systems [12].

2.2. Research method of the acceptance surveys

The standardised surveys on the acceptance and willingness to use telepresence robotics after a stroke were conducted as part of the accompanying social science study (see figure 1). They included the test subjects (patients), their relatives and care and therapy staff in the environment of the patients [13]. Questionnaires of all surveys were developed based on tested items and scales and a technology acceptance model specifically adapted for the study and the respective target group [14]. The model named “TePUS-TAM” is in turn based on the technology acceptance model developed by Davis [15, 16, 17]. Here, acceptance is defined as a process in the context of an individual decision to use a technology. Attitude is a precondition for behaviour.

Study participants and relatives were surveyed in panel with two waves once before and once after the intervention using standardised, largely identical questionnaires.

Nursing and therapy staff were surveyed in a cross-sectional study. Even though the accompanying study itself did not include an intervention, the panel design can be described as a pretest-posttest design, as the intervention as well as the intervention evaluation took place between the first wave t1 and the second t2 [18]. The collected interview data (face-to-face, written form or via video communication using TPR) were transferred to an online tool. The data was analyed using IBM Statistics SPSS 27. The additional verbal statements from patients and relatives collected and written down during face-to-face interviews were coded and analysed qualitatively with MAXQDA. In addition, a qualitative study on acceptance and willingness to use was conducted with various stakeholders being not part of the field study [19].

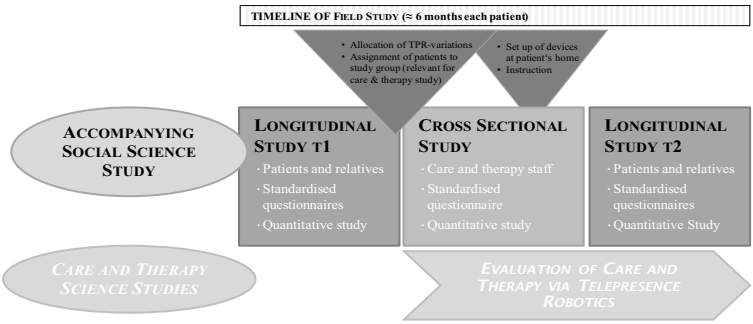

Figure 1. Research methods of the acceptance surveys

3. Results

3.1. How telepresence robotics are accepted

The study participants were asked about their attitudes towards using the technology both before the start of use (first wave) and at the end of the test phase (second wave). This is one of the core questions and the relevant target variable in our model. At the beginning of the study, patients' attitudes towards using the technology were at a very high level. Almost 91% stated that they could well or very well imagine using a TPR (n=44). This value was significantly lower after the end of the test phase and was still present in more than sixty per cent (64.9%, n=37). On the other hand, about 30% were negative and could not or could not at all imagine using it. The attitude towards both their own and the patient's behaviour was also positive at a high level among the family carers. It decreased slightly after the field test. In the first wave, n=51 family carers stated that they could well or very well imagine the test subjects using a TPR. This figure fell to 81.3% in the second wave (n=48). The nursing and therapy staff were only interviewed once after the test phase. At 93.5% (n=31), their (positive) attitude towards use by patients was at a very high level (see Figure 2).

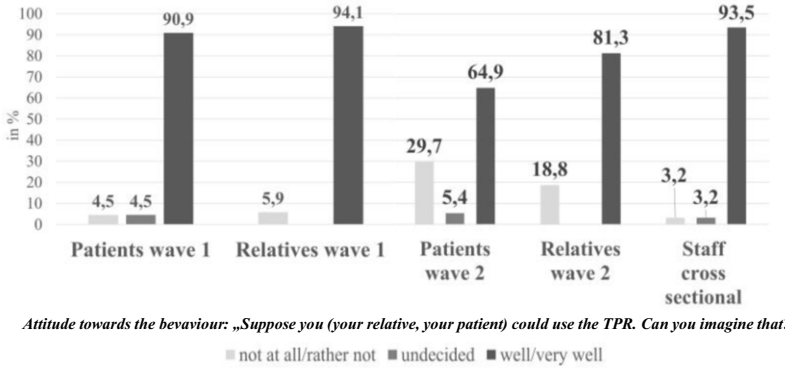

Figure 2. Attitude towards own behaviour (patients) and patient behaviour (relatives and staff) (in%) – first wave on the left, second wave and cross-sectional study of staff on the right.

The statistical correlation between the attitude values of the first and second wave is weakly positive for the patients (Rho = 0.261). Most patients (47%) remained stable in their attitudes (n=34). Few (8.8%) had more positive attitudes after the test phase than before. In each case, around 12% moved down one respectively two levels on the five-point scale. The attitudes of around 20% fell by three or more levels on the scale.

3.2. Technology acceptance

In our model, we assume that the general acceptance of technology plays a decisive role in whether there is a positive attitude towards the technology used and thus acceptance of use [20, 21]. The higher the level of technology acceptance, the more positive the attitude towards the use of telepresence robotics is expected to be. Technology acceptance was measured using an index made up of the constructs of technology use, technology access, technology affinity and technology competence. Validly tested items from various studies were used to formulate the questions for the construct of the TA Index [22-26]. The TA index can have values between 1 and 5, with 1 indicating a low level of acceptance and 5 indicating a high level. The index was collected in the first wave of patients and relatives as well as in the cross-sectional survey of therapy and care professionals. Although the three study groups differed in terms of age and gender, there were no significant differences in technology acceptance (table 1). A bivariate analysis showed the expected statistically significant age effect on the TA index for patients (n=44, Pearsons's r = -0,496, p<0,001) and relatives (n=48, ρ = -0,491, p<0,001), but not for nursing and therapy staff.

Table 1. Technology acceptance index of the study groups

	Mean	n	SD	Min	Max
Stroke patients	3,6	44	0,9	1,0	4,8
Relatives	3,7	50	0,8	1,2	5,0
Staff	3,9	31	0,7	2,2	4,8

3.3. Technology acceptance and attitude towards the use of telepresence robotics

The expected correlation between the TA index and attitude was found both in the target groups of relatives and staff in relation to their own use of telepresence robotics. The TA index and the attitude towards use, the acceptance of use, are statistically significantly related. However, such a correlation does not apply across the board for patients. Although the attitude towards behaviour correlates with the TA index in the first wave (Rho = 0.43, $p < 0.01$), this is not the case in the post-survey. Among relatives, the general technology acceptance index in the survey after the device test did not correlate with the attitude towards use by the patients being cared for. There was also no significant correlation between the general technology acceptance index and the attitude towards use by patients among the staff (Table 2).

Table 2. Acceptance of technology (TA Index) and attitude towards use of technology (acceptance of use)

	Patients	**Relatives**		**Nursing & therapy staff**	
Attitude to …	Own behaviour	Own behaviour	Patient behaviour	Own behaviour	Patient behaviour
First wave	0,43**	0,30*	0,35*		
Second wave	0,05	0,47**	0,26	0,38*	0,28

Spearman's Rho, * p< 0,05, ** p < 0,01

4. Discussion

As expected, in the bivariate analysis, age initially determined the acceptance of use of the TPR tested in each case. Overall, however, some of the expected correlations of the model regarding technology acceptance could not be confirmed. This applies in particular to the expected influence of general technology acceptance on the attitude to use *after* the device test: General technology acceptance still plays a significant role as an influencing factor for relatives before use in relation to patient behaviour and for nursing and therapy staff in relation to their own behaviour. After the device test, however, it was shown that technology use, technology access, technology affinity, technology competence and general technology acceptance among patients did not determine the acceptance of telepresence robotics. Even those who had not previously a pronounced affinity for technology were able to accept the technology at the end of the test phase. This also applies to nursing and therapy staff in terms of their attitude towards patients. The results of the study thus point in a direction that takes up the findings and demands of other studies. Age has not proven to be a determining factor for technology acceptance and therefore, like other studies imply, other variables should be included in the analysis [27-29].

Experience and knowledge of technology can increase acceptance. The level of knowledge on the subject of "teletherapy for stroke" surveyed in the first wave tended towards zero among both patients and their relatives. The variable could therefore not be used as an influencing factor to determine whether or not to use the technology. This is precisely where we need to start in the future, because, if necessary, patients will only consider what is already known [30]. Furthermore, our field study has shown that familiarisation, knowledge, experience, and handling of a technology can also lead to positive attitudes and acceptance of use, since even people who have been no "friends" of technology could imagine to use TPR. Possible reservations due to uncertainty in

dealing with the technology, which become barriers to acceptance, are reduced by concrete knowledge about the use and operation of the devices [19]. Relevant information combined with experience and familiarity are therefore ultimately one of the basic prerequisites for the sustainable use of technology in care and therapy.

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